Cognitive support for an argumentative structure during the ontology development process

Alexander Garcia Castro[1,2,3,4,§], Angela Norena[5], Andres Betancourt[5], Mark A. Ragan[2,4]
[1] *International Center for Tropical Agriculture*
[2] *Institute for Molecular Bioscience, The University of Queensland, Brisbane, Qld 4072 Australia*
[3] *Australian Center for Plant Functional Genomics*
[4] *Australian Research Council Centre in Bioinformatics*
[5] *Javeriana University, Engineering Facultity*
agcastro@cgiar.org, m.ragan@imb.uq.edu.au, {amnorena, andresbetancourt@puj.edu.co}

Abstract: Structuring and supporting the argumentative process that takes place within the knowledge elicitation process is a major problem when developing ontologies. Knowledge elicitation relies heavily on the argumentative process amongst domain experts. The involvement of geographically distributed domain experts and the need for domain experts to lead the design process, adds an interesting layer of complexity to the whole process. We consider that the argumentative structure should facilitate the elicitation process and serve as documentation for the whole process; it should also facilitate the evolution and contextualization of the ontology. We propose the use of conceptual maps as means to support and scaffold an argumentative structure during the development of ontologies within loosely centralized communities.

1. Introduction

The applications of knowledge engineering are growing larger and more systematic, now encompassing more ambitious ontologies—sizes in the hundreds of thousands of concepts will not be uncommon [1]. Furthermore, the development of those ontologies is usually a participatory exercise in which different experts interact *via* virtual means, resembling thereby a loosely centralized community. We believe the requirements of the Semantic Web (SW) bring with it an associated need for enhanced cognitive support in those tools we use.

Cognitive support is used to leverage innate human abilities, such as visual information processing, to increase human understanding and cognition of challenging problems [2]. Developing ontologies in loosely centralized environments as those described by Pinto *et al.* [3] poses challenges not previously considered by most existing methodologies. This user-centric design relies heavily on the ability of domain experts to interact with each other and with the knowledge engineer. By doing so the ontology evolves. Mailing lists, web forums, and WIKI pages usually support this interaction. Despite this combination of tools (none of them an ontology editor per se, nor a knowledge engineering tool), information is lost, documentation is poorly structured, and the process is not always easy to follow. This results in a decreased participation by the domain experts.

One of the key components in the development of ontologies in loosely centralized environments is the discussion related to each and every term and relationship/property. Pinto *et al*, as well as Tempich *et al* [3, 4] have proposed an argumentative structure to support and facilitate the discussion within the process of developing ontologies in loosely centralised environments. Both, Garcia *et al* and Hayes *et al* [5, 6], have studied the use of CMs during the elicitation process when developing ontologies in distributed environments. However, it is not clear how to support the proposed structure, nor what is the role of the argumentative process within the development of the ontology. The knowledge elicitation process, part of the whole ontology development, is a major bottleneck, particularly within those communities in which domain experts are geographically distributed. In order to assist the elicitation process and improve the interaction we propose the use of CMs as a means to scaffold the argumentative structure.

This paper is organized as follows. Firstly we provide some background information, and present our approach to the problem of supporting argumentative structures. We explain in section two what is an argumentative structure within the context of ontology development, we also present in this section the

§ Corresponding author: agcastro@cgiar.org

relationship between a CM and the argumentative structure proposed by Tempich *et al* [4]. In section three we present our CM plug-in for Protégé and elaborate further how our plug-in supports, assists and facilitates the argumentative process. We present a brief discussion and conclusions in section four.

2. Argumentative structure and CMs

Central to ontology development is the process by which domain experts and the knowledge engineer argue about terms/types and relationships. This collaborative interaction generates threads of arguments [3, 4, 7], and there is a need to support the evolution and maintenance of this argumentative process in a way that makes it easy to follow and, more importantly, links to evidence and provides room for conflicting points of view. Figure #1 {not italicised} presents the argumentative structure proposed by [4].

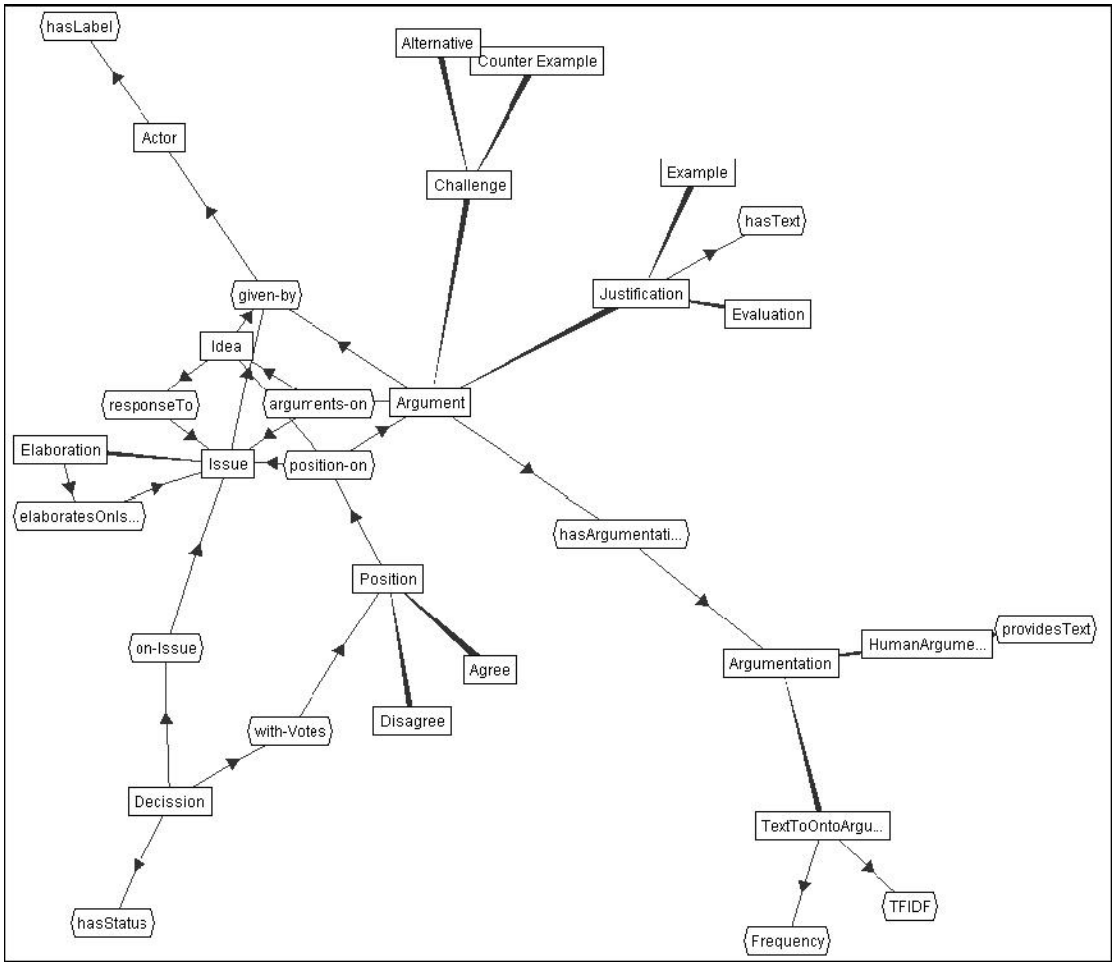

Figure #1 The major concepts of the argumentation ontology and their relations. Reproduced with permission from [4]

CMs are semantically valid artefacts without OWL constraints; concepts and relationships are the main scaffold of a CM. At any given point during the argumentative process one has a concept/class and a relationship/property. The evolution of the discussions increases the amount of information attached to the concept or relationship, the argumentative structure is enriched as domain experts provide arguments and base them upon evidence, which may be a paper, a commentary, or more generally a file of any kind (*idem* information source). The different views of the world can be represented with a CM, and the evidence may be attached to the particular concept/class or relationship/property at hand. This graphic representation facilitates the continuous exchange of information amongst domain experts –sharing knowledge. Following the threads of the discussions is not always easy for domain experts. The information exchanged is usually structured as an email-based chat. The knowledge engineer has to follow these text-based discussions in which there is mostly verbal knowledge, filter them, and at some point "formalise" that implicit knowledge. Moving from verbal knowledge into formalised-shared knowledge is difficult; some information is usually lost, the evidence supporting those different positions is not always provided by domain experts, and most importantly keeping domain experts

engaged throughout the entire process is not always possible. Cognitive support is thus required so we may facilitate the useful flow/exchange of information and at the same time record the entire process.

3. Argumentation *via* CMs

Concepts and relationships resemble the two key components within an argumentative structure: arguments and positions. During the development process we argue in relation to a concept and/or a relationship. Positions are supported upon evidence, and the simple argumentative structure is by itself a particular view of the world that is being modelled. Figure *#2* illustrates the basics behind the relationship between CMs and an argumentative structure.

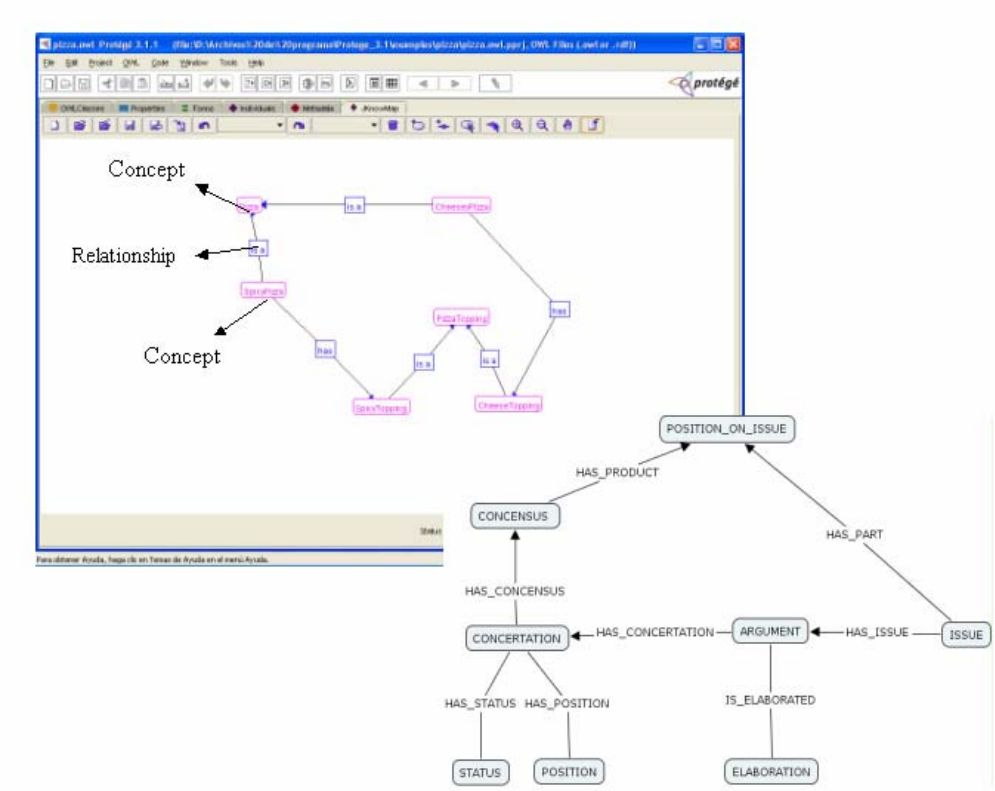

Figure #2. A simplification of the argumentative structure presented by [4]. The pizza example (http://www.co-ode.org) is used in order to illustrate our simplified argumentative structure.

For any given **issue** there is an **argument** that is elaborated by presenting the conflicting positions. The **elaboration** provides instances --concrete examples. For any issue there is a *concertation*[1] process that presents argument-elaborated conflicting positions. Once a consensus is reached there is a position on the issue initially at hand. The issue is well focused and specific, the same is true for the argument. It supports a position with simple and few words whereas the elaboration of the argument tends to be larger, and supported by different files (idem. pdf, ppt, doc, xls). Although there may be more than one argument for any given issue, there is only one elaboration for each argument. The dispute resolution process (also known as conciliatory process) produces a position on the particular issue; with in this process the knowledge engineer acts as a facilitator. Discussions over terminology, and over conceptual models, tend to address one issue at a time, this is highly dependent on the knowledge engineer.

A very important part of the whole process is the management of the history. Tracing back the argumentation process from the position_on_issue to the elaboration for a particular argument; being able to "see" the argumentative structure in order to "stand" on a particular place. The history should also allow us to go back and take an alternative route, thus we see the history not just as a simple undo" but as a more complex feature. An interesting starting point for complex history management is the one

[1] Concertation. From the French *concertation*. A conciliatory processes by which two parts reach an agreement.

provided by PhotoShop, a framework in which it is possible to see the whole process, take different routes, define blocks of work, and many other features that are always part of the manipulated image.

4. Discussion and conclusions

For any given **issue** there is an **argument** that is elaborated by presenting the conflicting positions. The **elaboration** provides instances -concrete examples. For any issue there is a process that presents argument-elaborated conflicting positions. Once a consensus is reached there is a position on the issue initially at hand. The issue is well-focused and specific, the same is true for the argument. It supports a position with simple and few words, whereas the elaboration of the argument tends to be larger and supported by different files (idem. pdf, ppt, doc, xls). Although there may be more than one argument for any given issue, there is only one elaboration for each argument. The dispute-resolution process (also known as the conciliatory process) produces a position on the particular issue; within this process the knowledge engineer acts as a facilitator. Discussions over terminology, and over conceptual models, tend to address one issue at a time and this is highly dependent on the knowledge engineer.

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